

Flexible Non-Contact Laser-Soldering for Solar Cell Strings

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Today, the process to connect individual solar cells and solar strings with conductive ribbon is almost entirely automated. With cells becoming increasingly thinner and therefore more sensitive, the challenges facing this technology are growing. Cells, ribbons and flux have to be soldered together in various combinations at lower cycle times in a dependable and capable process.

Only a minimum of thermal stress can occur in order to avoid stress cracks on the cell and the cell-ribbon connections.

Today's standard stringing technologies use different soldering processes. Soldering with infra-red light (IR-light) is one of the oldest and best known. Other common technologies are induction, hot-air and contact soldering.

As a market leader in high-throughput production systems, teamtechnik specialises exclusively in non-contact soldering technologies such as IR-light and laser soldering. The latter offers a considerable advantage with the trend towards thinner cell material, as the energy required is not applied two-dimensionally to a surface but with pinpoint precision. This technology minimizes the amount of heat acting on the solar cell. The precisely controlled application of soldering energy provides great flexibility in a wide range of applications. For example, in addition to conventional cells, back-contact cells and other ribbon geometries can also be laser soldered.

Throughout the soldering process, a hold-down device developed specifically for this purpose by teamtechnik ensures the precise positioning and alignment of cell and ribbon.

One of the primary differences in the system periphery is that this concept enables soldering only to be carried out at this stage and there is no additional handling. With the hold-down device, all the other processes can be done in parallel. This reduces costly processing time and a cycle time of three seconds can be accomplished throughout the machine.

Both of these non-contact soldering processes, IR-light and laser, can be integrated in teamtechnik's standard stringers. The end-user can choose between two basic chassis, a TT900 allowing 900 cycles/hour and a TT1200 allowing 1200 cycles/hour.

What are the primary objective criteria for evaluating soldering quality? They are the pull-off force of the ribbon and the homogeneity of the soldered section. The pull-off forces are defined as the force required to peel the ribbon from the cell. These forces should be at least 1N per millimeter width of the ribbon. The pull-off forces depend on the quality of the cell, the flux and the ribbon and how they are combined. The soldering result should ideally provide high pull-off forces with low cell tension. In addition, a homogeneous and consistent joint along the busbar is required. Stress causes faulty joints to crack open between the cell and the ribbon, reducing conductivity and current flow in the whole of the solar panel.

How does laser soldering work in detail? The laser beam generates energy that is applied

Profile: teamtechnik Group

Based in Germany, teamtechnik has been making intelligent and reliable automation solutions for the automotive industry and for medical and solar technology for over 30 years. With their focus on assembly and testing, the systems are distinguished by their modular and standardized process-oriented structure. teamtechnik is considered an international leader in highly flexible automation technology. With a total of 400 employees throughout the world, the company achieves sales of over €75 million. The majority of the workforce are engineers and highly qualified specialists. The teamtechnik-Group has production sites in Germany and Poland and two sales/service centers in the US and one in China.

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with precision in order to melt the solder on the ribbon. The energy is concentrated into just a few millimeters, and moved precisely with a scanner throughout the area of the soldered joint. A non-contact pyrometer constantly feeds back temperature readings in order to control the laser spot precisely. The laser then serially scans the busbar and accurately solders the ribbon to the cell so as to achieve high geometrical quality in the length, straightness, cell gap, cell/ribbon position and alignment.

The actual soldering process is supported by multiple heat zones which pre-heat the cells from below and activate the flux. Each heat zone can be adjusted and controlled separately and the temperatures for pre-

and post-soldering can be set precisely according to the cell-type.

Axel Riethmüller, manager of teamtechnik's solar division, summarizes the primary advantages of laser-soldering: "Laser technology provides a very high level of flexibility for fine tuning in order to achieve the best possible soldering results on different material combinations and alloys. A machine is therefore not restricted to one cell type but can be used for different cell types and sizes. The closed-loop process balances out variations in the material to achieve stable and continuous soldering quality. When running different cell types on one and the same machine, there is no mechanical adjustment required to adapt

the soldering to the different busbars. The adjustment is carried out via recipes only."

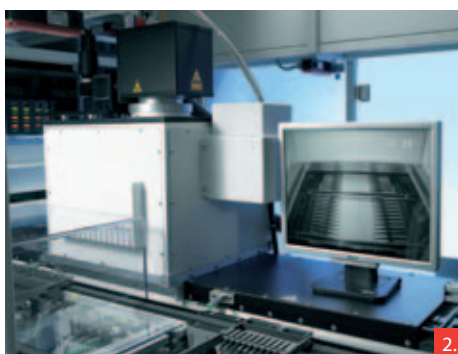
Today laser technology is still an expensive soldering method.

Nevertheless, at our customers' request approximately 50% of the stringers built by teamtechnik are equipped for laser soldering. One reason is undoubtedly that the flexibility of laser technology will allow more scope for dealing with the challenges that future materials might bring.

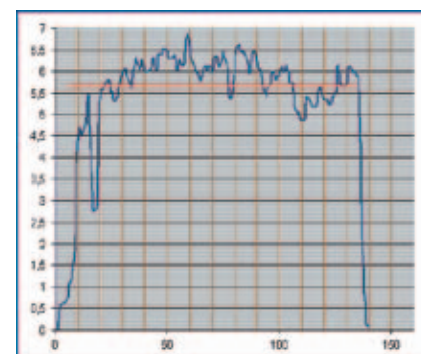
teamtechnik also benefits from this technology and has successfully completed tests on 130mm thick cells and unleaded ribbon.



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1. STRINGER TT by teamtechnik: optionally with IR-light or laser technology
2. Laser process for more flexibility
3. Laser Technology: precise and contiguous soldering
4. Pull-off force testing
5. Stringer machine assembly at teamtechnik